WESTERN CANADA LRTAP ACTIVITIES

ANNUAL REPORT 1984

A report on monitoring and research studies related to acid rain and long range transport of atmospheric pollutants in western Canada

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A report on monitoring and research studies related to acid rain and long-range transport of atmospheric pollutants in western Canada

prepared by the Technical Committee for the Long Range Transport of Atmospheric Pollutants in Western Canada

March 1984

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MAP OF WESTERN CANADA

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1. INTRODUCTION

Deputy Ministers and senior officials from Environment Canada and the environment departments of British Columbia, Alberta, Saskatchewan and Manitoba met in Edmonton on September 4, 1980, to review available information on acid rain and long-range transport of air pollutants (LRTAP) in western Canada. At that time, they concluded that acidic deposition was not a serious problem in the West. With an increase in industrial activity in western Canada and the western United States, the deputy ministers subsequently agreed that continued vigilance against acid rain and LRTAP was indeed warranted. They agreed to establish a Consultative Committee of deputy ministers and a Technical Committee of senior officials from the four western provinces and Environment Canada to coordinate monitoring, research and other activities on acid rain and LRTAP.

In December, 1982, the deputy ministers of the participating agencies, which by then included representation from the Northwest Territories, signed an agreement for a three-year research program covering the period 1982 to 1985. The program's objectives included identifying current conditions in western Canada, and providing the information necessary for the agencies to develop appropriate management strategies. Six program priorities were established as follows:

(1) maps of aquatic sensitivity
(2) maps of soil and geology sensitivity
(3) monitoring of background precipitation
(4) modelling of atmospheric deposition patterns
(5) emission inventories of sulphur dioxide and nitrogen oxides, and
(6) monitoring of surface waters and soils in data sparse areas.

A brief review of the current findings in response to the six program priorities above listed is provided below.

1. Maps of aquatic sensitivity

It was agreed by the participating agencies that Saskatchewan should coordinate the agencies' activities. Standards to be followed by each agency were developed. The Inland Water Branch of the Environmental Conservation Service, Environment Canada offered to plot the data and to draw the sensitivity maps by computer. Data for Saskatchewan have been provided. British Columbia has completed hand drawn maps. Manitoba and Alberta expect to provide the required data by the end of the year. Preliminary maps should therefore be completed by March, 1985. During the tabulation of the data, it became clear that there was a lack of information,especially in areas suspected to be sensitive. Agencies like British Columbia Ministry of Environment intensified their aquatic sampling program to fill the gaps. However, to date, large areas remain devoid of data — especially the Northwest Territories where most of the information available is for river water quality rather than lake water quality. The parameter coverage was also found to be limited.

2. Maps of soil and geology sensitivity

The participating agencies agreed that British Columbia should coordinate this activity. Standards to be followed by each agency were developed. To date, the mapping process is proceeding favourably using soil inventory data and other existing information. Gaps have been identified but no new data have been collected. British Columbia, the Northwest Territories, Saskatchewan and the Yukon have completed their maps except for border adjustments. The map for Manitoba will be completed by the end of the year and the Saskatchewan/Manitoba border discrepancies have been resolved. Alberta expects to have maps completed by March, 1985.

3. Monitoring background precipitation

The CANSAP network, in operation since 1977, is now being replaced by the Canadian Air and Precipitation Monitoring Network (CAPMON). CAPMON has been established in Manitoba and in all provinces of Eastern Canada. It will be extended to the remainder of the western provinces in 1985. The number of observing sites will be reduced. However, the frequency of sampling will be increased from monthly to dai-

ly and siting and sampling procedures have been improved. The Cree Lake air and precipitation station in Saskatchewan will become part of the new network.

The Atmospheric Environment Service (AES) carried out an event sampling study on the west coast of British Columbia. The study indicated that backround pH values were near 5.4 and that both local and U.S. sources may be responsible for lowering the pH of rain over the southern Strait of Georgia.

In addition to the CANSAP monitoring program each province developed or expanded its own monitoring network.

Snowpack samples have also been collected by the various agencies to determine chemical constituents and pH of the snow. A review of the sampling and analytical procedures by Environment Canada showed that a variety of collection and analytical procedures have been making it difficult to compare the data. A standardized protocol is being developed.

4. Modelling of atmospheric deposition patterns

The Atmospheric Environment Service long-range transport model was applied to selected locations in Western Canada to estimate sulphate deposition from industrial sources. The data base was obtained from the 1978 CANSAP data and the Environment Canada 1978 emission inventory. It was found, as expected, that dry deposition of sulphur was greater than wet deposition close to major sources while at remote sites the wet deposition dominated. Depositions in sensitive regions of the Northwest Territories, Saskatchewan and Manitoba were approximately 15% to 20% of the eastern target loading of 20 kg/ha/yr sulphate for the protection of moderately sensitive lakes. The background deposition included in the modelling was greater than 50% of the calculated total wet sulphur deposition. This suggests that increased attention must be given to quantifying the spatial and temporal properties of the background deposition in western Canada. The model underestimated the wet deposition of sulphate. Because no measurements of dry deposition existed for 1978, comparison with modelled values was not possible. Further testing is required for a better evaluation of the value of this modelling approach for Western Canada.

5. Emission inventories of sulphur dioxide and nitrogen oxides

Inventories of sulphur dioxide and nitrogen oxides emissions are being compiled. Some agencies have already completed the task; others are in the process of completing it. It is expected that the complete data for 1981 and 1982 will become available by March, 1985 and yearly updates will be forthcoming.

6. Monitoring of surface waters and soils in data sparse areas

Some agencies carried out new monitoring activities to address this specific priority, however, much more is required in this area in the future.

The next three year (1985-1988) program is under development by the Technical Committee and it will be highlighted in the annual report for the year 1985.

This document, the fourth annual report of the Technical Committee, summarizes monitoring and research activities on acid deposition and LRTAP conducted in western Canada during 1984.

2. British Columbia

2.1 Emissions and Control Technology

Emission Inventory

British Columbia Environment initiated provincial emission inventories for nitrogen oxides, sulphur dioxide, and other gaseous pollutants. These contracted studies will produce data for the year 1983 as part of an ongoing project to maintain regularly updated information on all emissions in the Province.

Results: Data will be available from the Waste Management Branch, British Columbia Environment.

2.2 Air Quality and Deposition

Precipitation Acidity in British Columbia

Precipitation chemistry samples have been collected on a weekly basis by automatic samplers at six permanent stations by British Columbia Environment. These stations are located at Kitimat, Smithers, Dawson Creek, Kamloops, Victoria and Cranbrook. They complement Environment Canada's network of stations in the Province, described in Section 7 and provide a warning of possible regional scale problems deserving further attention.

Results: In Victoria about 64% of the samples were moderately acidic and 18% of the samples were strongly acidic. In Kitimat 40% of the samples were slightly acidic and 28% were moderately acidic. In Terrace 40% of the samples were slightly acidic. For all the other stations, viz, Smithers, Dawson Creek, Cranbrook and Kamloops, the acidity was normal.

The sulphate deposition rates in Victoria, Kitimat and Smithers were 18.7, 13.4 and 2.3 kg SO_4/ha/yr. respectively with sea salt correction.

Wet Sulphate Deposition Criteria

Recognizing that acid rain standards (deposition criteria) established for eastern Canada might not be directly suitable in western Canada due to differences in climate, emission characteristics, and environmental sensitivity, British Columbia Environment initiated in 1983, an internal review of deposition rates in various parts of the world together with the associated impacts on the environment. This review is continuing and has been linked with a review of criteria for pH and aluminum in surface waters.

Report: A scientific report entitled "Acid Deposition in Aquatic Ecosystems: Setting Limits Empirically" by C.P. Newcombe will be published in the periodical "Environmental Management" (Vol. 9, Issue 3, 1985). Reprints are available from the Fisheries Branch, British Columbia Environment.

Monitoring and Quality Control

British Columbia Environment has continued to participate in national inter-laboratory comparison studies, and in the work of the National Quality Assurance Subgroup.

The Environmental Laboratory prepared a 45 gallon composite rainfall sample to be used in future National inter-laboratory comparison studies featuring low level samples.

Results: For further information, contact the Environmental Laboratory, British Columbia Environment.

2.3 Surface Waters

Surface Water Sampling

During 1984, British Columbia Environment collected surface water samples at about 120 lakes which had not been sampled previously. The data were collected to provide background information for lake sensitivity mapping programs. To date, lake data have been collected on about 95 lakes in the Province north from 56°N, a remote area identified in preliminary lake sensitivity maps as having had no data collected. Samples were analyzed at a minimum for pH, calcium, magnesium, alkalinity, and aluminum. In addition, associated ions, metals, nutrients and solids measurements were made at most of these sites.

Results: Data available through Water Management Branch, British Columbia Environment.

Aquatic Macrophites and Lake pH

A report summarizing pH ranges at which aquatic macrophites have been recorded grow-

ing in British Columbia lakes was prepared in 1984.

Results: Copies of the report are available through the Water Management Branch, British Columbia.

Lake Sensitivity Mapping

British Columbia Environment prepared preliminary lake sensitivity maps for the Province in 1982: one based upon calcium data, one based upon alkalinity data, and one which compiled sensitivity classifications from both the calcium and alkalinity maps. In addition, a map based upon pH showing present lake acidity was prepared. All maps were based upon data collected from 1977 through 1981 following the criteria outlined by the Coordinating Committee on Surface Waters. Using data collected until about the end of 1983, an updated lake sensitivity map was prepared in 1984. The updated map shows that the lakes within about 150 km from the Pacific Ocean have a high sensitivity.

A paper describing the mapping program in British Columbia, and outlining questions which arise when carrying out such a program, was presented to the NWAES Conference "Across the Border: Transboundary Environmental Issues in the Pacific Northwest", held at the University of Victoria in November, 1984.

Report: Copies of these maps and this paper are available through Water Management Branch, British Columbia Environment.

Lake Trend Monitoring

During 1984, a long-term trend monitoring program was begun on nine lakes in southwestern British Columbia; six of these are located on southern Vancouver Island, one located on Saltspring Island, and two in the Lower Mainland area. The purpose of this program is to document changes in the lakes which may result from the input of airborne contaminants. Water chemistry is monitored monthly, year round and zooplankton and phytoplankton are monitored monthly from May to October. Water samples are analyzed for pH, alkalinity, hardness, nutrients, metals, solids and ions. Zooplankton and phytoplankton are identified and counted, with metals to be measured once or twice during the peak growing season. Chlorophyll-a analyses are conducted. Once every five years, aquatic macrophytes are mapped in each lake and a sediment sample collected from the deepest point in the lake and analyzed for metals and nutrients. Monitoring indicates that the lakes are highly sensitive, with pH values between 6.0 and 7.5.

There are no indications that the aquatic biological communities are being affected at this time. Any developing trends will take at least five years to become evident.

Results: Data available through Water Management Branch, British Columbia Environment.

2.4 Soils and Geology

British Columbia Soils Sensitivity Mapping

Three draft maps (1:2 000 000) with legends relating to soil and geology sensitivity have been prepared for British Columbia. The first, a combined soil and geology base map depicts distribution of soil and geology characteristics significant to acidic input sensitivity. The second, an interpretive map, is entitled: "Potential of Soils and Geology to Reduce Acidity of Incoming Acidic Deposition". It attempts to show the ability of the land to modify acidity of precipitation and its subsequent impact on aquatic systems. This map shows large portions of Vancouver Island, the Queen Charlotte Islands, and a broad band along the Coast of B.C. (150-200 km) to have low potential to reduce acidity. Areas on Vancouver Island rated as moderate are so rated due to underlying slightly calcareous or mafic rocks. Soils have low potential. The third map, also interpretive, is entitled: "Sensitivity of Soils to Acidity Inputs". It portrays the pattern of B.C. soils and their ability to resist chemical changes due to acidic inputs which would affect vegetation. It shows all of Vancouver Island, the Queen Charlotte Islands, a broad band along the West Coast (150-200 km), large parts of northwestern B.C., as well as interior and Kootenay area mountains to have high sensitivity. These areas have relatively high potential for changes affecting vegetation. Final revisions of the draft are in progress following meetings of the Soils and Geology Sensitivity Mapping Task Group on September 5 and 6, 1984.

Report: Three 1:2 000 000 maps with legends and accompanying report. For information contact the Waste Management Branch, British Columbia Environment.

Soil Sensitivity of the Lower Fraser Valley

Maps of soil sensitivity to acidification for the Lower Fraser Valley have been prepared (1:25 000; 36 sheets). The ratings and maps have been generated by computer using input data from soil surveys. Exchangeable base content of soils was the criteria for rating sensitivity. Values were corrected for bulk density and content of coarse fragments. Tabular reports of statistics on soil properties and areas by sensitivity class are available.

Results: Soil sensitivity maps (1:25 000) and legends on topographic base maps for the Lower Fraser Valley. Legends explain briefly the ratings and class limits. For information contact the Waste Management Branch, British Columbia Environment.

Buffer Capacity of Some British Columbia Soils

Analysis of data and report preparation for a study of buffering capacity of selected soils is still ongoing. As reported in the 1983 Annual Report, laboratory titration curves and statistical analysis were already completed in 1983.

Results: Draft report still in preparation. For information contact Waste Management Branch, British Columbia Environment.

2.5 Vegetation Sensitivity

Lichen Response to Sulphur Dioxide

Lichen sampling was repeated after three years of exposure in the spring of 1983 in the vicinity of a natural gas processing plant in Chetwynd.

The data for two background sites and two impacted sites have been analyzed. Findings are being assessed, and a report is in preparation.

Report: A report will be available from the Waste Management Branch, British Columbia Environment.

2.6 Health

There are no monitoring programs or studies underway relative to health effects from acidic deposition.

3. Alberta

3.1 Emissions and Control Technology

Industrial NO_x Emissions for Alberta 1978-1982

An inventory of oxides of nitrogen (NO_x) emission sources in Alberta will be compiled. Emission totals, both observed and licenced, for individual plants and industrial groups are included along with observed trends.

Report: A final report will be available early in 1985 from the Pollution Control Division, Alberta Environment.

Gaseous Emission Control Technology

A wide range of concepts/processes for the control of acid gas emissions will be assessed and developed. Source industries such as gas processing, thermal power, oil sands, gas compressors and waste incineration will be considered. The use of magnesium oxide to remove sulphur dioxide gas from a sour gas processing plant has been developed and successfully tested at bench-scale with a pilot-scale project under consideration for funding by Environment Canada.

Report: A progress report on the bench-scale tests will be available in 1985 from the Environmental Technology Wing, Alberta Environmental Centre.

Emission Guidelines for Fossil Fuel Fired Thermal River Generating Plant

For the past few years ongoing discussions have taken place by the three major Alberta utilities – Edmonton Power, TransAlta Utilities and Alberta Power Limited – with Alberta Environment on guidelines for emissions of particulates, oxides of sulphur and oxides of nitrogen for the Alberta utilities.

Report: A final report was released in April 1984 and it is available from the Air Quality Branch, Standards and Approvals Division, Alberta Environment.

3.2 Air Quality and Deposition

Dry Deposition of Acid Forming Emissions in Alberta

The field testing of measurement techniques for the dry deposition of sulphur dioxide and the subsequent derivation of dry deposition velocities was continued. This project will: (1) measure, on a continuous basis during the growing season, ambient concentrations of sulphur dioxide; and (2) collect integrated data on the quantity and quality of dry and wetfall particulate matter. The information generated can be used to assess the total sulphur deposition occurring in the vicinity of an Athabasca Oil Sands plant and define the source-receptor relationships.

Report: An initial report of 1983 results will be available and a final report will be prepared in 1985. These can be obtained from the Research Management Division, Alberta Environment.

Airborne Pollution Measurement and Trajectory Analysis

Initiated in 1982 as a cooperative effort between the Alberta Research Council and Alberta Environment, this three-year project investigates the dispersion and transport of acid forming emissions from point source plumes in the oil sands area near Fort McMurray. Measurement will be made in both the winter and summer seasons.

Report: Two interim reports will soon be available and a final report is in preparation. These documents can be obtained from the Research Management Division, Alberta Environment.

Chemistry of Winter Precipitation in the Oil Sands Area

As an ongoing project since 1976, the accumulated snowpack in the Fort McMurray area has been extensively sampled and chemically analyzed. The objective is to quantify the total ionic and particulate loading to the snowpack and to qualitatively assess the spatial distribution of pollutant deposition. This information will provide baseline data to assess the impact of future industrial developments in the area.

Report: A summary report will be available in 1985 from the Research Management Division, Alberta Environment.

Chemistry of Summer Precipitation in the Oil Sands Area

Rainfall has been collected on an event basis in the Fort McMurray area since 1976. The chemical composition of the samples will be evaluated to determine the amount and distribution of wetfall deposition. Objectives of the study are: (1) to quantify changes in the input rate of atmospheric trace substances; (2) to establish a data base for the identification of trends in the chemical composition of the precipitation; and (3) to monitor the level of background pollutants.

Report: A preliminary report can be obtained from the Research Management Division, Alberta Environment.

Precipitation Chemistry Data Analysis

The data collected during the summer and winter precipitation chemistry projects will be subjected to stringent quality control criteria. The data will be evaluated statistically to determine: (1) relative contributions of local and distant sources of each chemical; (2) historic trends in deposition; and (3) the suitability of both field and laboratory procedures used.

Report: A final report will be prepared by mid-1985 and will be available from the Research Management Division, Alberta Environment.

Diffusion and Deposition Modelling for Point Source Emissions

A set of models is maintained in order to estimate concentrations and deposition downwind of point sources. The level of input data determines the selection of the specific model to be used. New models are added as they become available and older ones are upgraded as required. Existing and proposed point sources and complexes of point sources are evaluated for regulatory purposes. Occasionally guide models are promulgated for general use.

Report: A guide for estimated sulphur deposition resulting from point source emissions (Draft, Jan. 1984) and the computer codes (SULDEP2 and FREDIS) are available on request from the Pollution Control Division, Alberta Environment.

Precipitation Quality Monitoring Network

The chemical composition of precipitation is monitored at several permanent sites in Alberta. The objective of the project is to detect significant changes resulting from industrialization within the province and to provide an historical data base.

Report: Data reports are produced annually and a five-year summary is in preparation. These are available from the Pollution Control Division, Alberta Environment.

Air Quality Data Acquisition for Research on Permanent Sample Plots

An air quality monitoring station was established in the vicinity of a biological monitoring plot in the oil sands area near Fort McMurray. The station will measure on a continuous basis both meteorological data and ambient concentrations of acid forming gases. This information will be beneficial in assessing the response of terrestrial ecosystems to pollution episodes. The data generated will be used to develop numerical models for interfacing atmospheric/air quality data to receptor response measurement.

Report: An initial report for 1983 will be available from the Research Management Division, Alberta Environment.

3.3 Surface Waters

Aquatic Sensitivity Mapping

Maps of the sensitivity of surface waters in Alberta to deposition of acid forming emissions are in preparation. Parameters of concern include: pH, calcium, magnesium, alkalinity and total dissolved solids.

Report: A final report will be completed early in 1985 and will be available from the Research Management Division, Alberta Environment.

Alberta Lakes Monitoring

A total of 35 lakes are being monitored for physico-chemical characteristics and biological parameters. Objectives for the study include: (1) gathering baseline data; (2) identifying long-term trends in measured parameters; and (3) determining the natural variations in specific lakes.

Report: Reports will be available on completion of the project from the Pollution Control Division, Alberta Environment.

River Monitoring Network

Monthly water samples from 11 stations located on Alberta's major rivers will be collected and analyzed to determine the long-term trends of a series of physico-chemical parameters.

Report: Annual reports are available from the Pollution Control Division, Alberta Environment.

Athabasca River Basin Study

Rivers in the Athabasca River basin are being monitored to: (1) generate a data base of parameters defining their existing water quality; and (2) permit the development of a predictive capability of a river's water quality.

Report: A report for each river studied will be available on completion of the project from the Pollution Control Division, Alberta Environment.

Monitoring Southern Alberta Irrigation Reservoirs

Five irrigation reservoirs in southern Alberta will be sampled to discern their physico-chemical characteristics and biotic status. An assessment will be made of the suitability of each reservoir for domestic and other uses.

Report: A report will be available in late 1985 from the Pollution Control Division, Alberta Environment.

Dickson Reservoir Monitoring

Composite samples will be collected from the Dickson Reservoir to characterize its chemical and biological water quality. A procedure will be developed for assessing the quality of future on-stream reservoirs. Consideration will be given to monitoring the sediment release of chemicals in addition to the vertical heterogeneity of the water column.

Report: A report will be prepared at the completion of the project and will be available from the Pollution Control Division, Alberta Environment.

3.4 Soils and Geology

Effects of Deposition of Acid Forming Substances on Organic Matter Decomposition/Nutrient Cycling in a Forest Ecosystem

Formerly described as two projects, this research effort will determine the effects of deposition of acid forming substances on: (1) organic matter decomposition; (2) nutrient release from decomposing litter; (3) distribution and leaching characteristics of key nutrients in the litter/soil system; and (4) the uptake of nutrients by mycorrhizal and non-mycorrhizal jackpine seedlings.

Report: A final report will be available in the fall of 1985 from the Research Management Division, Alberta Environment.

Sensitivity Mapping

Maps of Alberta depicting soils and geology sensitivity to acid deposition are being prepared by the Alberta Research Council. These maps are based on the criteria outlined by the coordinating committee on soils and geology sensitivity mapping for western Canada.

Report: A report with maps, scale 1-2 000 000 will be available in 1985 from the Earth Sciences Division, Alberta Environment.

Sensitivity of Soils in Alberta to Acid Additions

In an attempt to map soils on the basis of their sensitivity to acidification, the project will investigate: (1) whether soil survey information can be used to assess relative sensitivity of soils; and (2) which soil characteristics are most useful in predicting buffer capacities.

Report: A final report will be available late 1985 from the Earth Sciences Division Alberta Environment.

Long Term Measurement of the Acidification of Non-Cultivated Soils in Alberta

Eight monitoring sites have been established to measure the acidification of soils over a long period of time in areas where deposition of industrial acid precursors is expected. The monitoring sites are intended to measure the worst situations and, hence, act as soil acidification warning sites.

Report: A brief synthesis of procedures is available from the Earth Sciences Division, Alberta Environment.

Seasonal Fluctuations in Soil pH

As an aid to understanding the long-term changes in soil pH, the seasonal variations must also be understood. This study is designed to determine: (1) the best time to sample for soil pH to minimize the effects of seasonal changes; and (2) the best laboratory method of measuring soil pH.

Report: A report will be prepared at the completion of the project and will be available in early 1986 from the Earth Sciences Division, Alberta Environment.

3.5 Vegetation

Atmosphere-Biosphere Interface: Verification of the Model to Determine the Frequency Distribution of SO_2 Ground Level Concentrations

A frequency distribution model capable of predicting the frequency of occurrence and magnitude of ground level sulphur dioxide (SO_2) concentrations will be validated using actual SO_2 data collected in the Fort McMurray area. The validated model will be used to predict the frequency distribution of ground level SO_2 concentrations throughout the Oil Sands area. Areas of maximum SO_2 impact will then be selected for ecological studies to assess the potential impacts of acidification.

Report: A final report will be available in the fall of 1985 from the Research Management Division, Alberta Environment.

Atmosphere-Biosphere Interface: Application of a Numerical Model to Assess Growth Response of Jackpine to Chronic Atmospheric SO_2 Exposures

The correlation between the output of a validated model predicting the frequency distribution of sulphur dioxide (SO_2) ground level concentrations and the tree wood production in several jackpine stands will be determined. Located in the Fort McMurray region, this project will attempt to assess growth effects due to chronic exposures of SO_2.

Report: A final report will be available in the fall of 1985 from the Research Management Division, Alberta Environment.

The Response of Vegetational Communities to Aerial Emissions

The short- and long-term response of vegetational communities to aerial emissions is being investigated. Single annual surveys at several sites were done initially, however, numerous observations throughout the growth cycle are now made at four selected sites. A precise determination of phenological parameters will be made to allow correlation with continuous air quality data.

Report: Several annual reports are now available and a summary report covering four years of data collection will be available in the fall of 1985. These can be obtained from the Research Management Division, Alberta Environment.

Impacts of Air Pollutant Mixtures on Forest Vegetation and Soils

The study is designed to use both laboratory and field investigations to identify and quantify forest tree responses to single and multiple exposures of acid forming pollutants. For the Athabasca Oil Sands area, a predictive capability for changes in forest soils and vegetation will be made. Both current and future rates of pollution deposition are considered.

Report: Interim reports are now available and a final summary report will be available in the fall of 1985. These can be obtained from the Research Management Division, Alberta Environment.

The Effect of SO_2 Emitted from a Sour Gas Plant on the Development of Endomycorrhizas (VA) on *Phleum pratense L*

The physiological effects of sulphur dioxide (SO_2) on *Phleum pratense L* will be related to the subsequent effect on endomycorrhizas (VA) inhabiting the roots of this agriculturally important species. Laboratory fumigation and field site experiments over a two-year period will be used to monitor the effects on mycorrhizal root infection, root biomass and root exudation.

Report: When completed, the final report (in the form of a thesis) will be available from the Research Management Division, Alberta Environment.

3.6 Health

Health Effects on Sulphur-Containing Emissions (Inhalation Toxicology)

The program will examine, in vivo and in vitro, the effects of short- and long-term inhalation exposures of hydrogen sulphide and other sulphur compounds on laboratory rodents and livestock. The studies of the effects on the reproductive systems, lung defence mechanisms, pulmonary function, biochemistry and pathological changes are underway.

Report: Initial reports can be obtained from the Toxicology Group, Animal Sciences Wing, Alberta Environmental Centre.

Effects of Environmental Sulphur on Farm Animals

This study investigates the role of indirect exposure to sulphur containing emissions on Alberta cattle,specifically the incidence of certain reproductive and infectious diseases, reduced productivity and trace element nutritional deficiencies. The role of direct exposure of sulphur containing emissions on the health and productivity of cattle is also under investigation.

Report: Reports of a pilot project are available from the Toxicology Ground, Animal Sciences Wing, Alberta Environmental Centre.

NOTE: A joint Alberta government and industry Acid Deposition Research Program (ADRP) is now proceeding. For a complete description of this program, please see the Industry and Institution Activities section.

4. Saskatchewan

4.1 Emissions and Control Technology

Saskatchewan Air Emission Inventory of Sulphur Dioxide and Nitrogen Oxides

The inventory of sulphur dioxide and nitrogen oxides emissions is being updated for 1983. The inventory includes ten major source categories ranging from power generation and transportation to forest fires.

Report: A final report will be available in 1985, through the Air Pollution Control Branch, Saskatchewan Environment.

4.2 Air Quality and Deposition

Poplar River Thermal Power Plant Ambient Air Monitoring Program

Saskatchewan Environment monitors sulphur dioxide and suspended particulates at one location, Coronach.

Results: Data summaries are available through the Air Pollution Control Branch, Saskatchewan Environment.

Snowpack Chemistry in Northern Saskatchewan

To supplement the snowpack chemistry studies conducted in northern Saskatchewan, Saskatchewan Environment has established a long term snowpack chemistry monitoring program. The program involves the collection of snow samples at six sites annually in northern Saskatchewan. The samples will be analyzed for pH, sulphate, nitrate, chloride, ammonium, alkalinity and metal ions scan. The first samples will be collected in February, 1985.

Results: Data summaries will be available through the Air Pollution Control Branch, Saskatchewan Environment.

Chemistry of Summer Precipitation in Northern Saskatchewan

Rainfall is collected, on an event basis, at seven sites in northern Saskatchewan. Chemical analyses for sulphate, nitrate, chloride, ammonium, potassium, calcium, sodium, magnesium, pH, alkalinity and metal ions scan provide data for evaluation of deposition rates.

Result: Data summaries are available through the Air Pollution Control Branch, Saskatchewan Environment.

Analysis and Interpretation of Summertime Precipitation in Northern Saskatchewan

The rainfall data collected by Saskatchewan Environment for the summertime periods of 1982 and 1983 are being analyzed. Precipitation back trajectories are being prepared and total sulphate and nitrate deposition rates are being estimated for each monitoring site.

Report: A report will be available in 1985 through the Air Pollution Branch, Saskatchewan Environment and the Saskatchewan Research Council.

4.3 Surface Waters

Surface Water Sampling in Northern Saskatchewan

Approximately 60 surface water stations in northern Saskatchewan are monitored. Most of these are collected by industry at the request of Saskatchewan Environment.

Results: Data summaries are available through the Water Pollution Control Branch, Saskatchewan Environment.

Surface Water Sampling in Southern Saskatchewan

Saskatchewan Environment collected surface water samples at about 35 lakes in southern Saskatchewan during 1984 which had not previously been sampled. The data were collected to provide background information for the lake sensitivity mapping program. The samples were analyzed for pH, sulphate, nitrate, calcium, magnesium, alkalinity and aluminum. In addition, associated ions, metals, nutrients and solids measurements were made.

Results: Data summaries are available through the Air Pollution Control Branch, Saskatchewan Environment.

Lake Water Chemistry for Small Lakes in Northern Saskatchewan

A long-term lake water chemistry monitoring program was initiated by Saskatchewan Environment in 1984. The program involves the collection of water samples at 22 sites uniformly distributed throughout northern Saskatchewan. The samples are analyzed at a minimum for pH, sulphate, nitrate, calcium, magnesium, alkalinity, and aluminum. In addition, associated ions, metals, nutrients and solids measurements were made.

Results: Data summaries are available through the Air Pollution Control Branch, Saskatchewan Environment.

Lake Sensitivity Mapping

Work is underway with respect to mapping lakes on the basis of their sensitivity to acidification. Existing data dating back to 1977 has been collected and documented. Preliminary lake sensitivity maps have been prepared for the province: one based upon alkalinity data, one based upon pH data and one which combined sensitivity classifications for both calcium and alkalinity maps. All maps are based on criteria outlined by the Coordinating Committee on Surface Waters.

Results: Copies of these maps will be available in 1985 through the Air Pollution Control Branch, Saskatchewan Environment.

4.4 Soils and Geology

Sensitivity Mapping

Maps of Saskatchewan depicting soils and geology sensitivity to acid precipitation have been prepared by the Saskatchewan Institute of Pedology. However, the maps are subject to modification at the borders to match up with the maps being prepared by Manitoba and Alberta. The maps are based on the criteria outlined by the Co-ordinating Committee on Soils and Geology Sensitivity Mapping.

Report: The maps and report will be available in 1985 through the Air Pollution Control Branch, Saskatchewan Environment and the Saskatchewan Institute of Pedology.

4.5 Vegetation

An Evaluation of the Sensitivity of Saskatchewan Forest Vegetation to Acidic Precipitation

A laboratory study is being conducted by the Saskatchewan Research Council involving the use of simulated acid rain to evaluate the response of common Saskatchewan forest trees to various levels of precipitation acidity.

Report: A report will be available by mid-1985 through the Air Pollution Control Branch, Saskatchewan Research Council.

4.6 Health

No specific monitoring activities or studies are underway with respect to health effects from acidic deposition.

5. Manitoba

5.1 Emissions and Control Technology

No specific studies are underway with respect to emissions and control technology. However, emission inventories for nitrogen dioxide and sulphur dioxide are being maintained by the Province.

Results: A report of nitrogen dioxide and sulphur dioxide emissions for the years 1981 and 1982 is available as well as data summary for the succeeding years from Manitoba Environment and Workplace Safety and Health.

5.2 Air Quality and Deposition

Air Quality Monitoring in Northern Manitoba

Atmospheric sulphur dioxide is measured on a continuous basis downwind from the two major non-ferrous smelters at Flin Flon and Thompson. The network consists of two stations within the Flin Flon area and one in Thompson. Total reduced sulphur compounds are measured at one site near the MANFOR kraft pulp and paper mill at The Pas.

Results: Data summaries are available from Manitoba Environment and Workplace Safety and Health.

Precipitation Monitoring

Precipitation is sampled on a daily basis at Norway House, Island Lake, Gillam, Brochet and Pointe du Bois. The following parameters are analyzed: pH, conductance, acidity, sulphate, nitrate, chloride, calcium, ammonium, magnesium, sodium and potassium.

Results: Data summaries are available from Manitoba Environment and Workplace Safety and Health.

Snowpack Survey

A winter snowpack survey is being conducted within the boreal forest ecosystem surrounding the smelters in Flin Flon and Thompson. Seven sampling sites are located around Flin Flon and twelve near Thompson. At each site replicate samples are taken with a Mount Rose sampler and analyzed for pH, sulphate, zinc, lead, copper, nickel, iron, cadmium and arsenic. The snowpack survey also includes 18 stations through-out the province. Samples are analyzed for pH, conductance, acidity, sulphate, nitrate, chloride, calcium, ammonium, magnesium, sodium and potassium.

Results: Data summaries are available through Manitoba Environment and Workplace Safety and Health.

5.3 Surface Waters

Surface Water Sampling

Approximately 3,500 sites, located within NTS map Sections 64B, 64F and 64G of Northern Manitoba, were sampled as a part of a Geochemical Reconnaissance Program operated jointly by the Manitoba Geological Services Branch and the Federal Government.

The chemical analyses of the samples are being carried out by the Manitoba Environmental Management Laboratory.

Results: Data summaries are available through Manitoba Environment and Workplace Safety and Health.

Aquatic Sensitivity Mapping

Existing water quality data are being compiled for the preparation of computer drawn aquatic sensitivity maps.

Results: Data summaries are available through Manitoba Environment and Workplace Safety and Health.

5.4 Soils and Geology

There are no routine soil monitoring programs in progress.

Terrestrial Sensitivity Mapping

Terrestrial Sensitivity mapping in cooperation with other jurisdictions of Western Canada and based on existing information has been completed.

Results: Maps and data are available through Manitoba Environment and Workplace Safety and Health.

5.5 Vegetation

Vegetation Surveys Around Thompson

LANDSAT (Land Satellite Imagery) in the Thompson area was evaluated this summer with financial assistance from INCO Limited.

Results: A report is available from the Manitoba Environment and Workplace Safety and Health and/or from INCO Limited.

Tree Regeneration Study Near Thompson

A total of four plots have been established near Thompson, with financial assistance from INCO Limited, to study "on site" the effect of plant growth under the conditions created by the Thompson smelter. Tree seedling were transplanted on the study plots and soil surveys were completed.

Results: This is an on-going study. Interim results are available from the Manitoba Environment and Workplace Safety and Health.

Tree Seedling Studies

Green house studies of tree seedling growth in soil from Thompson which contains high levels of metals have been completed and the findings are being analyzed.

Results: Data summaries are available from the Manitoba Environment and Workplace Safety and Health.

Jack Pine Growth Studies

A study of radial increment growth in jack pine trees in the general area affected by the Thompson smelter emissions was cooperatively carried out by the Ontario Department of Natural Resources.

Results: A report is available from the Manitoba Environment and Workplace Safety and Health.

Forest Impact Study of Smelter Emissions in Northern Manitoba

Forest vegetation in the Thompson and Flin Flon area was evaluated for impacts from smelter emissions. A report summarizing five years of studies was prepared.

Results: A report is available from the Manitoba Environment and Workplace Safety and Health.

5.6 Health

Mercury in Mink and Otter

Mercury levels in mink and otter in the Rat-Burntwood river system have been monitored.

Results: This is an ongoing program. Summary data are available from the Manitoba Environment and Workplace Safety and Health.

6. Northwest Territories

6.1 Emissions and Control Technology

No activities under this subject heading.

6.2 Air Quality and Deposition

Monitoring Background Precipitation

The Department of Renewable Resources established six CAPMON(Canadian and Air Precipitation Monitoring Network) stations in the Northwest Territories. The Atmospheric Environment Service is carrying out analysis of the samples.

Results: Contact the Pollution Control Division, Department of Renewable Resources, Yellowknife, N.W.T. or the Atmospheric Environment Service, Edmonton, Alberta.

6.3 Surface Waters

Aquatic Sensitivity

The Government of the Northwest Territories undertook a snow chemistry and lake water survey of six small lakes in the Precambrian shield area of the southwestern portion of the Northwest Territories. The survey and analysis was conducted by Dr. S.R. Shewchuk of the Saskatchewan Research Council. The Inland Waters Directorate has completed a draft of an Aquatic Sensitivity map for the Northwest Territories. The Territorial Government has supplied information to help fill data gaps.

Results: Information may be obtained from the Pollution Control Division, Department of Renewable Resources, Yellowknife, N.W.T., and the Inland Waters Directorate, Regina, Saskatchewan.

6.4 Soils and Geology

There are no routine soil monitoring programs in progress.

Soils and Geology Terrestrial Sensitivity Mapping

Maps presenting the potential of soils and bedrock in the Northwest Territories to reduce the acidity of precipitation are being prepared. Soil exchangeable bases , soil depth, soil texture, bedrock exposure and bedrock lithology are used for these interpretations. The maps are based on guidelines prepared by the Task Group on Soils and Geology Sensitivity Mapping to ensure compatibility with the Western Provinces and the Yukon Territories.

Results: For further information contact the Pollution Control Division, Department of Renewable Resources, Yellowknife, N.W.T.

6.5 Vegetation

No activities under this subject heading.

6.6 Health

No activities under this subject heading.

7. Environment Canada

7.1 Emissions and Control Technology

Emission Control Review

The Environmental Protection Service (EPS) has completed, in 1984, two studies under contract to the private sector and one report by EPS Western and Northern Region concerning acid gas emission control:

1) Investment and Operating Costs Associated with Additional Sulphur Recovery Facilities for the Canadian Natural Gas Processing Industry. March, 1984.

2) Characterization of Trace Constituents at Canadian Coal Fired Power Plants.

3) Current Acid Gas Emission Control Options for Western Canada — A Review. October, 1984.

Contents of reports commissioned under contract are the responsibility of the authors.

Reports: Further information is available from the Environmental Protection Service, Edmonton.

7.2 Air Quality and Deposition

Canadian Network for Sampling Precipitation (CANSAP)

Stations in this network have samplers which open only during precipitation events. Samples are removed daily and analyzed on a monthly basis for pH, conductivity, sulphate, nitrate, chloride, ammonium, potassium, sodium, magnesium and calcium. The network includes the following distribution in Western Canada.

Alberta:
- Fort McMurray
- Edson
- Coronation
- Lethbridge
- Rocky Mountain House

Saskatchewan:
- Cree Lake
- Kindersley
- Wynyard

British Columbia:
- Fort St. John
- Fort Nelson
- Vancouver
- Terrace
- Prince George
- Kelowna
- Port Hardy
- Revelstoke

Northwest Territories:
- Hay River
- Inuvik
- Fort Reliance
- Mould Bay

Yukon:
- Whitehorse

The CANSAP Network is being replaced by an improved monitoring network, the Canadian Air and Precipitation Monitoring Network (CAPMON). Conversion of the CANSAP network to CAPMON has been completed in Manitoba and eastern Canada. CAPMON provides improved quality assurance for the sampling and analysis of atmospheric constituents through the upgrade of siting and instrumentation, implementation of revised laboratory procedures and use of a computerized archiving system. Two CAPMON stations were in operation in Manitoba at Island Lake and McCreary. Cree Lake in Northern Saskatchewan was the only CAPMON station west of Manitoba.

Results: Data summaries are published routinely and are available from the Atmospheric Environment Service, Vancouver, Edmonton and Winnipeg.

Air and Precipitation Network (APN) Station: Cree Lake

Cree Lake, because it is remote from sources of industrial emissions, is an excellent site for the measurement of regional air quality precipitation chemistry. Precipitation, suspended particulate matter and sulphur dioxide are collected daily. The site started operation in 1982.

Results: The data are available through the Atmospheric Research Directorate, Atmospheric Environment Service, Downsview.

Hydrometereology of CANSAP Sampler

Evaporation represents a large portion of the difference between sample and standard gauge precipitation amounts. This alters the concentration of ions in the sample and if not properly accounted for lends to erroneously high calculated deposition. Both CANSAP and CAPMON

samplers have been installed at the official observing site at Regina Airport. Samples will be measured daily (weight) to determine evaporative loss and undercatch.

Results: Further information is available from Atmospheric Environment Service, Regina.

Acid Deposition Model for Western Canada

The AES-LRT model has been applied in Western Canada to 1978 CANSAP data to determine acid deposition. To confirm initial results and use improved quality CANSAP data, the model is being run for the months of January and July, 1982. In addition the regions will be able to access remotely the CRAY computer in the Canadian Meteorological Centre, Montreal and run the LRTAP models from the west.

Report: A final report on the study using 1978 data and further information are available from the Atmospheric Environment Service, Edmonton.

B.C. Transboundary Model for Western Canada

An event monitoring network of 12 stations, located on a line parallel to the US/CAN border from the west Coast of Vancouver Island eastward to the Lower Fraser Valley, has been in operation during 1983 and 1984. The data indicate that emission sources south of the border as well as local sources, have lowered the pH of rain in the lower Strait of Georgia. ASARCO Smelter, the major source of sulphur dioxide emissions south of the border, has announced it will terminate its smelting operations in the spring of 1985. The network has been augmented by including upper air data, aerosol sampling and snowpack analysis. The sampling program will provide data to assess the effects of the shutdown.

Reports: A preliminary report is available from the Atmospheric Environment Service, Vancouver.

Chemical Analysis of Snowpacks in Southern B.C.

A report has been prepared on the Composition of Snow in Pacific Coastal Mountains. The distribution of surface and snow core chemical composition is available from the 18 locations sampled. In remote areas the pH was approximately 5.4, near the value of "clean precipitation". Near Vancouver, the pH was depressed to near 5 with increased sulphate and nitrate concentrations. Further inland, the pH increased but not to the values observed at the remote sites.

Results: Report available from the Atmospheric Environment Service, Institute for Ocean Sciences, Sidney, British Columbia.

Sulphur Deposition Analyses for Western Canada

A study has been completed on the evaluation and analysis of precipitation chemistry data from Western Canada and the Northwest Territories. The existing data, particularly sulphate deposition has been analyzed from an informational and research viewpoint.

Report: A report is available from the Atmospheric Environment Service, Edmonton.

7.3 Surface Waters

Water Chemistry Sampling — Northwest Territories, IWD, Regina

The Indland Waters Directorate, Environment Canada, monitors water quality at 6 river sites in the Northwest Territories.

Results: Data summaries are available from the Inland Waters Directorate, Environment Canada, Yellowknife.

7.4 Soils and Geology

Soil and Bedrock Sensitivity Mapping for Yukon

Preliminary maps of sensitivity of soils and bedrock to acid deposition have been prepared for the Yukon.

Results: Available from the Pacific Forest Research Centre, Canadian Forestry Service, Victoria.

7.5 Vegetation

Acid Rain National Early Warning System

The Acid Rain National Early Warning System was established to clearly and accurately detect early signs of acid rain damage to forests before damage becomes obvious. A nationwide network of permanent plots has been established by the Canadian Forestry Service to detect and monitor changes in forest soil, vegetation and trees. A total of 15 plots will be established in the Pacific Region and 15 in the Northern Region during the three year period 84/85-86/87. ARNEWS plots will remain in existence for a planned 20-25 year time period.

Results: Further information is available from the Northern Forest Research Centre, Canadian Forestry Service, Edmonton and the Pacific Forest Research Centre, Canadian Forestry Service, Victoria.

8. Fisheries and Oceans Canada

8.1 Surface Waters

Effects of Pollution Deposition on Fish and Other Aquatic Organisms

Research programs are designed to detect the effects of atmospheric deposition of pollutants on fish and other aquatic organisms, to investigate the fundamental mechanism of affected life processes, and to evaluate limnological processes involved in buffering oligotrophic lakes. These programs are conducted in lakes impacted by base-metal smelters, in experimentally acidified lakes and in the laboratory. Emphasis is placed on establishing the priority of sulphuric and nitric acids, on determining the contribution of metal contamination and toxicity to adverse effects on fisheries, and on developing sensitive indicators of stress induced by the atmospheric deposition of pollutants on fish and other aquatic organisms.

Results: Data available from Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Manitoba.

Fisheries Related Surface Water and Snowpack Baseline Chemistry Monitoring in British Columbia and the Yukon

Surface water sampling was carried out on a limited number of Pacific salmon watercourses in the British Columbia Interior Lower Mainland region. These data and data obtained in 1983 from surface water and snowpack sampling in the British Columbia coastal region and the Yukon have been compiled and a report is in preparation. The data will provide a benchmark to assess long term trends in acidification and buffering capacity. These studies have been conducted by Fisheries and Oceans Canada with cooperation from the International Pacific Salmon Fisheries Commission.

Results: Data available from the Water Quality Unit Habitat Management Division, Fisheries and Oceans Canada, Vancouver.

9. Jointly Managed Activities

9.1 Emission and Control Technology

Air Pollution Emission Inventory

A nationwide inventory of sources and emissions of air contaminants is published biannually. The report on 1980 data is being completed.

Report: A report is available from the Environmental Protection Service, Edmonton and Vancouver.

9.2 Air Quality and Deposition

National Air Pollution Surveillance

NAPS Stations are operated cooperatively by federal and provincial agencies in each of the western provinces. Measurements include sulphur dioxide, nitrogen oxides, carbon monoxide, ozone, and/or particulates.

The distribution is as follows:

Manitoba:	
Winnipeg	5
Brandon	1
Saskatchewan:	
Regina	2
Saskatoon	2
Moose Jaw	1
Lloydminster	2
Estevan	2
Alberta:	
Edmonton	7
Calgary	5
Red Deer	1
Medicine Hat	1
Lethbridge	1
British Columbia:	
Greater Vancouver Regional District	12
Prince George	1
Victoria	1
Kamloops	1
Penticton	1
Northwest Territories:	
Yellowknife	1
Yukon:	
Whitehorse	1

Results: Data summaries are available from provincial environment departments or Environmental Protection Service at major centres.

Lower Mainland Ozone

The Vancouver/Lower Mainland area is one of three regions in Canada which regularly experience high levels of ozone. Accordingly, a joint investigation was launched during 1984 by British Columbia Environment, Environment Canada and the Greater Vancouver Regional District. A control strategy report drew attention to the significance of automobile exhaust contributing to ozone formation, and recommended a variety of actions and studies needed to control the problem. The Minister of Environment, in releasing the report, noted that Vancouver was being established as the site of Canada's first ozone control strategy and that action was already underway on several of the recommendations.

Report: A report is available from the Waste Management Branch, British Columbia Environment.

10. Industry and Institution Activities

10.1 British Columbia

Acid Precipitation Effects in Aquatic Systems Applied to Freshwater Management Strategies

— Using experimental ecological manipulation of sensitive biofilm communities and in-field flow through microcosms to bioassay effects of acidification, metals and other toxins.

— Innovative procedures to evaluate, in the field, impact of several perturbants which ultimately result in decrease of water quality implicating organisms such as salmonids and other sport fish of social value

— Short and long term investigative procedures to generate some prediction of permissable concentrations and further consequences of initial impact and facilitate rehabilitation of damaged aquatic systems.

Results: Further information available from Dr. A.P. Austin, Department of Biology, University of Victoria.

Effects of pH on the Early Development and Growth and Otolith Microstructure of Chinook Salmon, Oncorhynchus Tshawytscha

Chinook Salmon (Oncorhynchus tshawytscha) eggs, alevins and fry were reared in pH 4.5, 5.0, 5.5, 6.2 (control) and 7.0 water from the eyed stage of development. Survival through hatching was > 90% in all instances. Alevin mortality was high at pH 4.5 and 5.0. Fry were more tolerant of low pH than alevins.Growth rates of alevins and fry held at or above pH 5.0 and 4.5 respectively were not affected by pH. Nor did exposure to acidic water retard otolith development or result in their resorption. One otolith daily growth increment was formed every 24 h in alevins and fry irrespective of pH. Chinook salmon population could be adversely affected by pH 5.0 water. Anticipated increases in metal concentrations in acidified waters would increase the pH at which the salmon stocks would be at risk.

Results: Further information available from G.H. Geen, Department of Biological Sciences, Simon Fraser University.

Assessment and Policy Implications of Air Pollution Effects on Silvicultural and Agricultural Resources in the Lower Mainland

Graduate work at the Ph.D. level in the Institute of Animal Resource Ecology, University of British Columbia, will focus attention on the problem of making defensible pollution control decisions in the highly unpredictable field of air pollution impacts. The study, being conducted by Mr. Gordon Brown under the supervision of Dr. Ilan Vertinsky, incorporates dose-response relationships in ecological systems. This knowledge is to be used to estimate the potential magnitude and costs of the damage — biological, social, and economic — associated with increased air pollution for a study area in Western Canada. This information will be used in a "decision framework" which will allow meaningful evaluation and comparison of alternate pollution control policies for Western Canada, based on existing knowledge. Decisions arrived at through this process, it is believed, will provide an optimal solution, reflecting society's willingness to tolerate pollution, balanced against its willingness to pay for pollution control.

Results: For further information contact the Institute of Animal Resource Ecology, University of British Columbia

Direct and Indirect Effects of Low pH on the Transformation of Detrital Energy and a Shredding Caddisfly, Clistoronia Magnifica (Limnephilidae)

We used a shredding caddisfly, Clistoronia magnifica Banks, to test the hypotheses that increased acidity would reduce the transformation of detrital energy into shredder biomass by (1) increasing maintenance costs (at the expense of growth), (2) reducing survival, and (3) reducing nutritional quality of coarse particulate organic matter because of inhibited microbial activity. Low pH reduced larval survival immediately after hatching and during the third to fourth instar moult. However, surviving larvae developed faster at pH 4.2-5.2 than at pH 5.8-6.4 and produced larger pupae and adults. Low pH did not alter metabolic costs or ingestion rates of fourth and fifth instar larvae.

Accelerated growth resulted from indirect effects of low pH on the food resource and suggested improved nutritional quality of leaf litter conditioned at pH 4. However, enhanced growth of late-instar larvae did not compensate for reduced survival of early instar larvae, possibly resulting in lower shredder production under acidic conditions.

Results: For further information contact the Department of Biological Sciences, Simon Fraser University.

Microbe-Medicated Effects of Low pH on the Fate of Detrital Energy Ingested by the Shredding Caddisfly, Clostoronia Magnifica (Limnephilidae)

Larvae of the caddisfly shredder, Clistoronia magnifica, grew more rapidly at pH 4.2-5.2 than at pH 5.8-6.4. That growth enhancement was postulated to result from microbe-medicated changes in nutritional quality of leaf litter conditioned at low pH. Alder leaves conditioned for more than 3 weeks at pH 4 had greater fungal biomass and bacterial abundance than leaves conditioned at pH 6. Differential microbial colonization did not alter ingestion rates. Experiments with labelled, conditioned leaves indicated that late instar larvae assimilated microbe-derived energy from leaves conditioned at pH 4 with a 10-15% higher efficiency than microbial energy from leaves conditioned at pH 6, and suggested a concomitant 5% increase in assimilation of leaf-derived energy. Enchanced growth of C. magnifica at low pH could be accounted for by increased, fungal abundance on leaves conditioned at low pH. We believe that increased fungal biomass and additional modification of the leaf substrate by fungal enzymes improved nutritional quality of those leaves.

Results: For further information contact the Department of Biological Sciences, Simon Fraser University.

Effects of Acidification on Stream Organisms

A project to determine the effects of acidification on stream organisms and to determine the mechanisms for change that take place in the community. Started in 1982, this project is continuing.

Results: For further information contact the Institute of Animal Resource Ecology, University of British Columbia.

10.2 Alberta

The Measurement of Deposition of Elemental Sulphur Dust with Nipher Gauges

Nipher gauges and other collection devices have been located up to 2 km downwind from two sulphur-producing gas processing plants. Monthly measurements of elemental sulphur catch will delineate the deposition pattern and identify the maximum distance of travel of sulphur dust from each source. The suitability of the collection systems used will be evaluated.

Report: Several conference presentation reports are available from Dr. M. Nyborg. Department of Soil Science, University of Alberta.

Effect of Elemental Sulphur Dust on Forest Soils

Four replicated field experiments have been established in the forests near two sulphur-producing gas processing plants. The effects of liming and fertilizing on the growth of introduced and natural vegetation established in soils made unproductive by the deposition of elemental sulphur dusts are being investigated. The fate of the added nitrogen will also be determined using isotope enriched fertilizers.

Report: Reports in the form of theses, will be available in 1985 and in 1986 from Dr. M. Nyborg, Department of Soil Science, University of Alberta.

Compressor Station Stack Design

The objective of this study is to obtain a calculation procedure prepared and evaluated for predicting the nitrogen dioxide (NO_2) concentration in the vicinity of natural gas compressor stations stack design. An existing model will be modified as required and validated using available data.

Report: A final report will be available at the end of this project from the Canadian Petroleum Association.

Alberta Government and Industry Acid Deposition Research Program

An agreement to commission major studies for an assessment of the long-term environmental impact of acid-forming gases was reached on March 17, 1983 between various industry sponsors and the Alberta government. The Acid Deposition Research Program (ADRP) was created to investigate the impact of acid deposition on the Alberta environment.

To ensure top calibre scientific design and impartiality, the ADRP invited internationally recognized scientists and communicators to three task-oriented workshops: (1) biophysical; (2) human health; and (3) communications. The purpose of the workshops was to develop a multi-disciplinary approach to the study and a strategy to inform and involve the public in the research program. The proceedings and recommendations of the three workshops have been published in a single volume, entitled "Researching Acid Deposition: Workshop Proposals". A major report outlining the program's findings, conclusions and recommendations will be released at the termination of the program.

Fifty percent of the funding for this Acid Deposition Research Program is being provided by the following sponsors: The Canadian Petroleum Association; the Independent Petroleum Association of Canada; Petro Canada; Nova, An Alberta Corporation; and Alberta's three principal utilities: TransAlta, Edmonton Power and Alberta Power. The balance of the funding (50%) is coming from the provincial Department of the Environment. The ADRP may cost up to eight million dollars ($8,000,000) over a seven-year period.

Report: Further information and copies of reports are available from the Acid Deposition Research Program.

Trace Constituent Research Program

A research program on the distribution of trace constituents between various release pathways from Canadian Coal-Fired Generating Stations and the potential effects of these emissions on the environment was awarded to Battelle Pacific Northwest Laboratories for the Canadian Electrical Association in 1980. The consultant conducted a detailed sampling and analysis program at four Canadian coal-fired power stations burning different types of coal at various locations within the facility. The contractor was required to analyze for a specified list of major constituents, trace elements and determine the distribution between major release pathways to the environment of the trace constituents identified. He was to assess the effectiveness of measures of controlling trace constituents for all release pathways, and critically evaluate trace constituent contributions to the atmosphere, aquatic and terrestrial environment at one of the stations sampled earlier.

Results: Further information is available from Alberta Power Limited.

Modelling of Long Range Transport and Acid Deposition

The objective is to develop a long range transport (LRT) and acidic deposition modelling system consisting of a hierarchy of LRT models which will provide a facility for the Canadian power industry with which to assess its impact on sensitive receptor areas. The first part of this multi-phase program is to review and evaluate on theoretical grounds, mathematical models which simulate long range transport of air pollutant and acidic deposition in a "statistical" manner and recommend one model for implementation in the CEA's LRT modelling system. The next part of the program is to review and evaluate Lagrangian long range transport models for the prediction of transport and deposition of acidic pollutants and to recommend one of these models for implementation on the CEA's LRT modelling system. The work is being conducted by Concord Scientific Corporation for the Canadian Electrical Association.

Results: Further information is available from Alberta Power Limited.

10.3 Saskatchewan

Saskatchewan Power Corporation Monitoring Activities at Poplar River (Coronach) and Boundary Dam (Estevan) Power Stations

Two stations continuously monitoring ground level concentrations of sulphur dioxide are located at the U.S. border. One is located south of the Poplar River Power Station and the other south of the Boundary Dam Power Station. Emissions at the Poplar River Power Stations are continuously monitored for opacity, sulphur

dioxide and nitrogen oxides concentrations. Surface waters in the vicinity of the Poplar River and Boundary Dam Power Stations are monitored at 10 sites and analyzed for pH, sulphates, nitrates, alkalinity, etc.

Results: Further information available from the Saskatchewan Power Corporation and the Air Pollution Control Branch, Saskatchewan Environment.

Saskatchewan Power Corporation Agricultural Monitoring Program — Poplar River Power Plant

As part of this program the Saskatchewan Research Council measured sulphation levels at 23 sites. Rainfall samples at six sites were collected and analyzed for pH, sulphate, nitrate, calcium, magnesium, potassium, sodium, chloride and specific conductance. Soil chemistry was monitored for pH and sulphur content and wheat crops were analysed for chlorophyll-a, nitrogen and sulphur.

Results: Further information available from Saskatchewan Power Corporation.

Low NO_x/SO_x Burners

Saskatchewan Power Corporation has conducted a study on the effectiveness of burners designed to reduce the quantities of nitrogen oxides and sulphur dioxides being emitted from coal-fired power plants.

Results: A report has been completed and a supplementary statistical evaluation has been completed. Reports and information available from the Director, Coal and Gas Research and Development Centre, Saskatchewan Power Corporation.

Leaching from Power Plant Emissions

The leachability of Saskatchewan lignite ashes as functions of their environment conditions and combustion histories has been studied. The data obtained deals primarily with major and minor ash constituents with some trace materials also examined. The program is in progress.

Results: Data and other information available from the Director, Coal and Gas Research, Research and Development Centre, Saskatchewan Power Corporation.

Monitoring at AMOK Ltd. Uranium Mine, Cluff Lake

The average sulphation levels are determined on a monthly basis at 23 sites around the mine using lead peroxide plates.

Results: Data summaries are available through Amok Ltd. and Saskatchewan Environment.

Monitoring at Eldor Mines, Uranium Mine, Rabbit Lake

Eldor Mines continuously monitor ground level concentrations of sulphur dioxide at one site.

Results: Data summaries are available through Eldor Mines and Saskatchewan Environment.

Chemical Studies of Acid Rain Impacts

The Chemistry Department, University of Regina, began a study in 1983 to experiment with techniques which may improve the analytical procedures for metals from snow, rain and lake samples. Lake sediment samples were also acidified to simulate the acidification process due to acid precipitation in order to study the release of metals from the sediments. The analytical techniques were further studied in 1984.

Results: Further information available from the Chemistry Department, University of Regina.

10.4 Manitoba

Monitoring in Thompson

A permanent station continuously monitoring ground level concentrations of sulphur dioxide is located to the north west of the non-ferrous smelter facility, between the plant and the town.

A mobile station is used during the spring, summer and early fall (during the growing season) to provide sulphur dioxide concentrations in other directions. In addition to measuring ground level concentrations of sulphur dioxide, there is a meteorological program to regulate the smelter production so that acceptable concentrations of sulphur dioxide are maintained under different dispersion conditions.

Satellite imagery is being used to detect and map vegetation changes in the Thompson area. Maps have been prepared for 1973 and 1978 and one for 1983 has been commissioned.

Results: Data summaries are available through Inco Limited.

Monitoring in Flin Flon

Three stations continuously monitoring ground level concentrations of sulphur dioxide are located within 4.8 kilometres of the 150 metre high main stack of the non-ferrous smelter facility. A high volume sampling program measures airborne particulate levels and determines heavy metal concentrations at two sites located 0.8 and 4.8 kilometres from the main stack. Dustfall is measured in the vicinity of the non-ferrous smelter facility at two locations 0.5 and 1.6 kilometres from the main stack to determine particulates for total solids, dissolved solids and ignition loss.

Results: Data summaries are available through Hudson Bay Mining and Smelting Company Limited.

11. Addresses for Further Information

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6th Floor, Oxbridge Place
9820 - 106 Street
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Alberta Power Limited
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Northwest Territories

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Federal Agencies

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Atmospheric Environment Service
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